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THE LOGGERHEAD TURTLES IN JAPAN AND NEIGHBORING WATERS (TESTUDINATA: CHELONIIDAE)[1)]

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With 5 Text-figures

There have been some confusions in the taxonomy and nomenclature of the loggerhead turtles occurring in the Japanese and adjacent waters. Most of previous authors regarded the population of the turtles found or caught in Japan and her adjoining waters as consisting of a single species, and applied to it the name *Caretta olivacea* (ESCHSCHOLTZ) or *Caretta caretta olivacea* (ESCHSCHOLTZ) (STEJNEGER 1907; TAYLOR 1921; OKADA 1927, 1938, 1947; TAKASHIMA 1932; POPE 1935; HIRASAKA 1943; UTINOMI 1943; NAKAMURA 1957; HOTTA 1960; etc.) These authors were, however, not right in two points: first they were not aware of the existence of two distinct species in the populations of the Japanese loggerhead species, and secondly some of them failed to find the correct scientific name for the commoner one generally known by the Japanese name '*aka-umigame*' (*aka* means red, *umigame* means sea turtle). For the first time in 1963, NAKAMURA and UÉNO revealed that the loggerhead turtles caught in the Japanese waters consist really of two distinct species belonging to the two different genera and designated them respectively as *Caretta caretta gigas* DERANIYAGALA and *Lepidochelys olivacea olivacea* (ESCHSCHOLTZ). Though the distinction and the descriptions of the two species by these authors were made properly, for some unknown reason the two scientific names were assigned to erroneously; i.e., *Lepidochelys olivacea olivacea* was applied to the true *Caretta caretta* (red-brown loggerhead in English; *aka-umigame* in Japanese) and *Caretta caretta gigas* was applied to the real *Lepidochelys olivacea* (Pacific ridley or olive loggerhead in English; *hime-umigame* in Japanese) (cf. NISHIMURA & HARA 1967).

Meanwhile, almost nothing has been described on the morphological details of the red-brown loggerhead population in Japan, though this sea turtle is quite common there as will be shown later (presumably this country may be the place of the densest occurrence throughout the western Pacific areas). This has made it difficult to scrutinize the opinion held by some herpetologists that the red-brown loggerhead is separable into the Indo-Pacific subspecies and its Atlantic counterpart (DERANIYAGALA 1933, 1939, 1943, 1945, 1946; CARR 1952; WERMUTH & MERTENS 1961; etc.)

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The present paper is prepared as the first step in the studies to reveal the details of the morphological characters of the loggerhead population breeding in southern Japan for the purpose of firstly showing definitely that the population is represented by a single species *caretta* LINNÉ, not *olivacea* ESCHSCHOLTZ, and secondly presenting a datum for future discussions on the subspecies problem of *Caretta caretta* on a world-wide scale.

Before going further, I wish to extend my hearty thanks to many persons who helped me in various ways; particularly I am indebted to Mr. Y. SHIBATA of the Osaka Museum of Natural History for his generosity in allowing me to avail his herpetological literature, and to Mr. CH. SUGIHARA of Sakata City, Yamagata Prefecture, for his kind information of the records of sea turtles in that province. The paper was read by Prof. H. UTINOMI and Dr. T. TOKIOKA of our laboratory, to whom I am so grateful.

Loggerhead Turtles from Sirahama and Other Localities in Southern Japan

In June to early August, at some nights of calm wind and bright moon light, some loggerheads will land on the sandy beach near the Seto Marine Biological Laboratory for egg laying. After the incubation of about two months, baby turtles hatch out. And usually one or two clutches of these newly-hatched baby turtles are brought to the laboratory aquarium where they are reared, being fed with fish meat; and occasionally some of them live more than ten years under human care. Thus, in September 1966, about a hundred hatchlings, four one-year individuals, five two-year individuals and several larger individuals of different ages are kept alive in the aquarium. In addition, some stuffed specimens are displayed in the specimen gallery of the aquarium. They are all from the vicinity of the laboratory, some in recent years and others long ago. These specimens, living and stuffed, form the material for the discussion made in this section.

Results of the measurement on the carapace of all the specimens examined are given in Table 1, and figures of the carapace, inframarginal scutes, head shields and mandibular scales of some representative specimens are presented in Figs. 1 to 4. The features shown in the table and text-figures, together with the characteristic red-brown coloration of the carapace, which becomes clear in the individuals older than one year or larger than about 15 cm in carapace length, are sufficient enough to assign all of the examined specimens to a single species *Caretta caretta* (LINNÉ, 1758)[2].

In describing and discussing the characters of these specimens, those of the olive loggerhead *Lepidochelys olivacea* (ESCHSCHOLTZ, 1829) will be referred to frequently for

2) Subspecific separation suggested by DERANIYAGALA (1933, etc.) and some other authors is not followed here, for the validity of subspecies does not seem wholly established.

comparison, since these two loggerheads have been confused so much in Japan and are still so in certain districts in the western Pacific.

Shape of Carapace. As seen in Table 1, the width varies from 74.2 to 94.4% of the length in the Sirahama specimens with 40 to 930 mm long carapace. These values nearly coincide with those given by BRONGERSMA (1961) for the Atlantic specimens of *Caretta caretta*. Besides the individual variation of a considerable wide range, there is seemingly a trend towards the decrease in relative width of the carapace with the growth. In *Lepidochelys olivacea* of similar size, on the other hand, the carapace is a little wider: CADENAT (1949) cites the carapace of three specimens of this species, 525

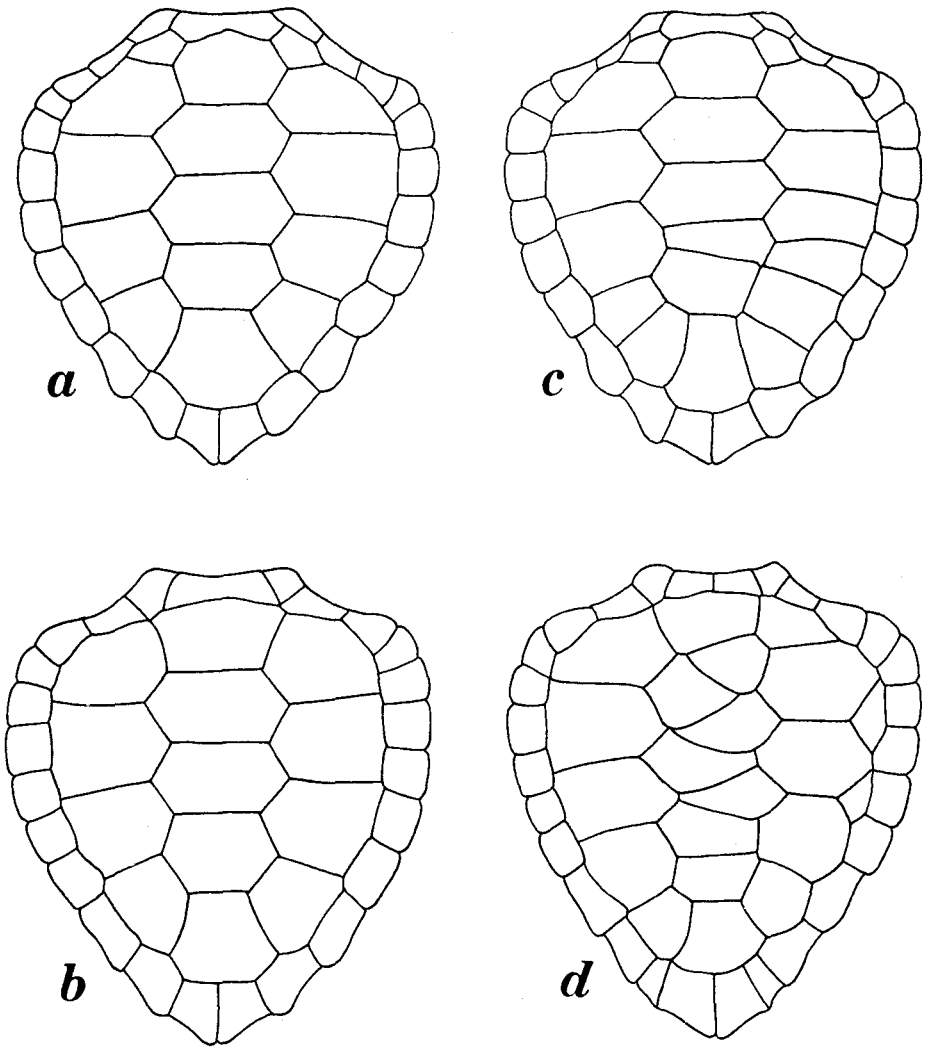

Fig. 1. Variations in the pattern of carapace scutes in hatchlings of *Caretta caretta* (LINNÉ) from Sirahama.
a.-Specimen no. 6627; *b.*-Specimen no. 6633; *c.*-Specimen no. 6628; *d.*-Specimen no. 6630.

Table 1. Measurements on *Caretta caretta* (LINNÉ) from Sirahama, southern Japan. Specimen nos. 6601 to 6625, 6626 to 6633, 6634 & 6635, 6636 to 6640, 6641 to 6660, 6501 to 6504 and 6401 to 6405 are respectively from the same clutch. Nos. OB1 to OB9 are each from different clutches.

Specimen no.	Carapace			Vert.	Costals		Marginals*		Inframarginals**		Inframarginal pore
	Length	Width	100× W/L		*l*	*r*	*l*	*r*	*l*	*r*	
6601	40 mm	34 mm	85.0	5	5	5	(1)12	(1)12	(1)3	(1)3	None
6602	40	35	87.5	5	5	5	(1)12	12	4	(1)3	None
6603	41	34	82.9	5	5	5	12	12	(1)3	4	None
6604	41	34	82.9	5	5	5	12	12	3	(1)3	None
6605	41	34	82.9	5	5	5	12	12	(1)3	(1)3	None
6606	41	35	85.3	5	5	5	(1)12	(1)12	4	(1)3	None
6607	41	35	85.3	5	5	5	12	(1)12	(1)3	(1)3	None
6608	41	35	85.3	5	5	5	(1)12	(1)12	4	4	None
6609	41	35	85.3	5	5	5	13	(3)11	(1)3	(1)3	None
6610	41	35	85.3	5	5	5	(1)12	(1)12	4	(1)3	None
6611	41	36	87.8	5	5	5	12	12	(1)3	(1)3	None
6612	42	32	76.3	5	5	5	(1)12	12	(1)3	4	None
6613	42	35	83.3	5	5	5	12	12	(1)3	(1)3	None
6614	42	35	83.3	5	5	5	(1)12	12	(1)3	(1)3	None
6615	42	35	83.3	5	5	5	(1)12	12	4	4	None
6616	42	36	85.8	5	5	5	12	(1)12	(1)3	(1)3	None
6617	42	36	85.8	5	5	5	13	13	(1)3	(1)3	None
6618	42	36	85.8	5	5	5	12	12	(1)3	(1)3	None
6619	42	35	83.3	5	5	5	(1)12	12	(1)3	(1)3	None
6620	42	35	83.3	5	5	5	(1)12	12	4	4	None
6621	42	36	85.8	5	5	5	12	12	(1)3	(1)3	None
6622	42	36	85.8	5	5	5	(1)12	(1)12	4	(1)3	None
6623	42	36	85.8	5	5	5	12	12	(1)3	(1)3	None
6624	42	36	85.8	5	5	5	(1)12	(1)12	(1)3	4	None
6625	43	35	81.4	5	5	5	12	(1)12	(1)3	4	None
6626	42	39	92.8	5	5	5	(3)11	12	4	(1)3	None
6627	43	39	90.7	5	5	5	12	12	4	4	None
6628	43	40	93.1	6	6	7	12	12	4	(1)3	None
6629	43	40	93.1	5	6	5	(2)11	(2)11	(1)3	(1)3	None
6630	44	39	88.7	9	5	5(SC2)†	11(1)1	11(1)1	4	4	None
6631	44	40	90.9	5	5	5	12	12	(1)3	(1)3	None
6632	44	40	90.9	5	4(SC1)	4(SC2)	12	12	(1)3.5	(1)3(1)	None
6633	46	40	87.0	5	4	4	12	12	3	3	None
6634	44	38	86.4	5	5	5	1(1)11	1(1)11	4	4	None
6635	51	47	92.2	5	5	5	(2)11	12	4	(1)3	None
6636	45	38	84.4	5	5	5	1(1)11	1(1)11	4	4	None
6637	45	38	84.4	5	5	5	12	12	3	3	None
6638	45	39	86.7	5	5	5	1(1)11	1(1)11	(1)3	4	None
6639	45	40	88.9	5	5	5	(2)11	1(1)11	(1)3(1)	(1)4	None
6640	46	40	86.9	5	5	5	(2)11	1(1)11	(1)3	(1)3	None
6641	49	44	89.8	5	5	5	(2)11	(2)11	4	(1)3	None
6642	49	44	89.8	5	5	5	(2)11	(2)11	4	4	None
6643	49	45	91.8	5	5	5	12	12	(1)3(1)	3	None
6644	50	45	90.0	5	5	5	12	12	(1)4	(1)3	None
6645	50	46	92.0	5	5	5	1(1)11	1(1)11	5	(1)4	None
6646	50	46	92.0	5	5	5	12	12	(1)3	(1)3(1)	None
6647	50	47	94.0	5	5	5	12	12	4	(1)4	None
6648	51	46	90.3	5	5	5	11(1)1	12	3.5(1)	4(1)	None
6649	51	47	92.2	4(1)1	6(SC1)	6(SC1)	12	1(1)11	(1)4	4	None
6650	52	49	94.3	5	5	5	12	12	(1)4	(1)4	None
6651	53	47	88.7	5	5	5	12	12	(1)3	(1)3	None
6652	53	48	90.6	5	5	5	12	12	(1)4	(1)4	None
6653	53	49	92.5	5	5	5	12	12	4	(1)3	None
6654	53	50	94.4	5	5	5	12	12	(1)3	(1)3	None

Table 1 (*continued*).

Specimen no.	Carapace			Vert.	Costals		Marginals*		Inframarginals**		Inframarginal pore
	Length	Width	100× W/L		*l*	*r*	*l*	*r*	*l*	*r*	
6655	54 mm	48 mm	88.9	5	5	5	(1)12	(1)12	(1)3	(1)3	None
6656	54	49	90.8	5	5	5	12	12	4	4	None
6657	54	50	92.6	5	5	5	12	12	(1)3	(1)3	None
6658	54	50	92.6	5	5	5	1(1)11	1(1)11	(1)3	(1)3	None
6659	55	49	89.2	5	5	6	12	12	(1)3	(1)3	None
6660	55	51	92.8	5	5	5	12	12	(1)3	(1)3	None
6501	118	102	86.5	5	5	5	12	12	(1)3	(1)3	None
6502	121	109	90.1	5	4	5	12	12	(1)3.5	(1)4	None
6503	132	109	82.7	4(1)1	5	6	12	12	(1)3.5	(1)3	None
6504	139	126	90.8	5	5	4	12	12	(1)3	(1)4	None
6401	170	153	89.9	5	5	5	12	12	4	(1)3	None
6402	175	155	88.7	5	5	5	12	12	3	(1)4	None
6403	180	166	92.3	5	5	5	1(1)11	1(1)11	(1)3	(1)3	None
6404	196	177	90.3	5	(1)4	4	12	12	(1)3	(1)4	None
6405	210	188	89.6	5	5	5	1(1)11	1(1)11	(1)3	(1)3	None
‡OB1	176	162	92.1	5	5	5	1(1)11	1(1)11	4	(1)3	None
‡OB2	185	158	85.4	5	5	5	12	1(1)11	(1)3(1)	(1)3	None
‡OB3	212	183	86.3	5	5	5	12	12	(1)3	(1)3	None
‡OB4	227	205	90.3	5	5	5	1(1)11	1(1)11	3(1)	3(1)	None
OB5	415	350	84.4	5	5	5	12	12	3	3	None
‡OB6	600	500	83.3	5	5	5	1(1)11	12	4	(1)3	None
OB7	610	485	79.5	5	5	5	13	12	(*not examined*)		
OB8	920	715	77.7	6	6	6	13	13	(*not examined*)		
‡OB9	930	690	74.2	5	5	5	1(1)11	12	(1)3	(1)3	None

* Including supracaudals. Number of scutes smaller than half the dimensions of normal marginals is parenthesized and inserted at suitable position.

** Number of small inframarginals, sometimes wedged in between marginals and axillaries (or inguinals) is shown in parenthesis just prior (or posterior) to the number of enlarged inframarginals.

† SC=supernumerary costals wedged in between costals and marginals.

‡ Stuffed specimen.

to 620 mm in carapace length, from the coast of Senegal, West Africa, the width of which is 86.4 to 97.1% of the length. DERANIYAGALA (1961) reports two specimens caught off India; in the 546 mm long female carapace the width is 98.4% of the length, while in the 680 mm long male carapace the width is 89.7% of the length. A few specimens of the same species accessible to me (cf. NISHIMURA & HARA 1967) show the following dimensions:

Locality	*Length (L)*	*Width (W)*	*100× W/L*
South Pacific (Yokosuka City Museum Specimen)	288 mm	278 mm	96.5
Shiganoshima, northwest Kyushu	450	430	95.6
Teradomari, near Niigata on the Japan Sea coast	620	580	93.5

Number of Vertebrals and Costals. Most or 93.6% of the 78 specimens examined have five vertebral scutes (Table 1), four or 5.1% have six, and a single specimen is found to have nine vertebrals abnormally arranged (Fig. 1*c*, *d*)[3], while none is known with vertebrals less than five. Five pairs of

3) A similar abnormality in vertebral scute arrangement is shown in a grown-up specimen from West Pakistan by MINTON (1962).

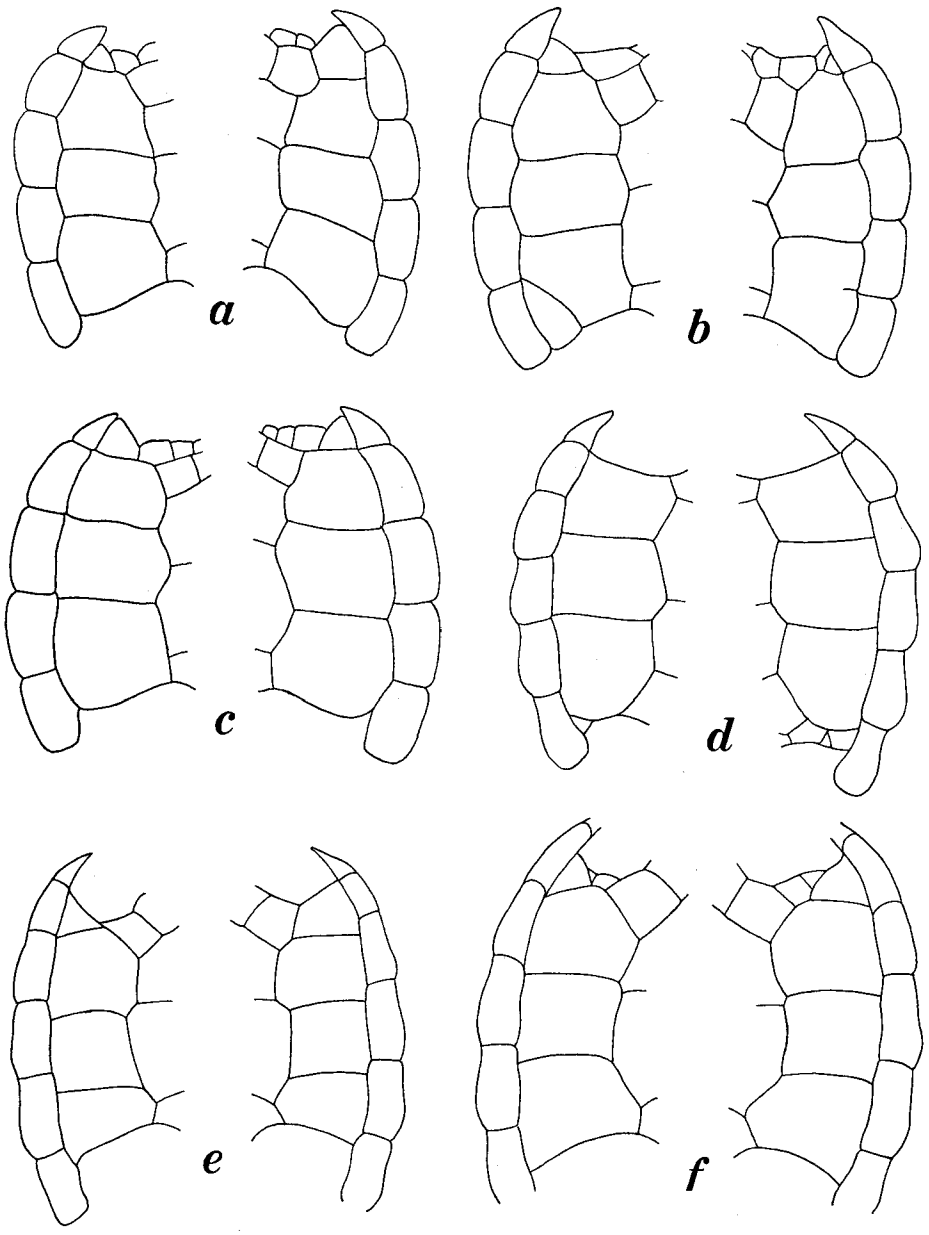

Fig. 2. Inframarginal pattern in *Caretta caretta* (LINNÉ) from Sirahama.
a.-Specimen no. 6628; *b.*-Specimen no. 6632; *c.*-Specimen no. 6658; *d.*-Specimen no. OB4; *e.*-Specimen no. OB6; *f.*-Specimen no. OB9.

costal scutes are met with most frequently, but ten individuals or 12.8% have costals of other numbers else than five on either or both sides (Table 1; Fig. 1*b, c*); for convenience' sake the number of costals on the right and left sides may be treated respectively as an independent statistic element, then four costals occur in seven of the 156 cases (4.5%), five costals in 142 cases (91.1%), six costals in six cases (3.8%), and seven costals in a single case (0.6%). The situation is quite different in *Lepidochelys olivacea*, which is armoured with four to nine, but mostly five to seven, vertebrals and three to nine, but mostly six or seven, pairs of costals (DERANIYAGALA 1939, 1961; LOVERIDGE & WILLIAMS 1957; BRONGERSMA 1961; NISHIMURA & HARA 1967; etc.) In three of the 78 specimens examined (3.8%), one or two supernumerary costals are found inserted between costals and marginals on both sides (two specimens) or on one side (one specimen) (Fig. 1*d*).

Number of Marginals. The number of marginal scutes (including supracaudals) on either side in the 78 specimens is distributed as follows: 12 marginals in 89 cases (57.0%), 13 marginals in 65 cases (41.7%) and 14 marginals in two cases (1.3%); the average number is calculated as 12.44. As seen clearly in Table 1, one or two marginals, most often those of the first or/and second pair, and rarely the anterior three marginals on either side are almost consistently smaller than the others in the cases of 13 or 14 marginals. This seems to suggest that 12 marginals are normal in the Japanese population of *Caretta caretta*. When DERANIYAGALA (1933, 1943, 1945, 1946) proposed two subspecies of *Caretta caretta*, he referred to the number of marginal scutes as one of the diagnostic characters by which he ascertained the propriety of subdivision; however, this seems quite doubtful as pointed by BRONGERSMA (1961). In this respect, it is interesting that the Sirahama specimens show the tendency to have marginals fewer by one than those in the specimens from the Indian Ocean (DERANIYAGALA 1961) or the Solomon Islands (CARR 1952).

Inframarginals. In the 76 specimens examined (in two large live individuals in the aquarium it was difficult to examine the plastron), the number of inframarginal scutes on either side is distributed as follows: three inframarginals in nine cases (5.9%), four inframarginals in 123 cases (80.9%) and five inframarginals in 20 cases (13.2%); the average number is 4.07. The anteriormost scute, and occasionally also the posteriormost one, in the individuals with four or five inframarginals are generally reduced in size as compared with the remaining scutes; the degree of reduction varies individually and in many cases it is impossible to make a clear distinction between the normal (enlarged) and the reduced inframarginals (Fig. 2). In no specimen are found inframarginal pores. It had ever been believed that *Caretta caretta* has constantly three enlarged inframarginals on either side, while *Lepidochelys olivacea* has four enlarged inframarginals, and this was accepted by NAKAMURA & UÉNO (1963), too. However, since 1952 when WILLGOHS reported a specimen of *C. caretta* with four enlarged inframarginals from the coast of Norway, evidences have been accumulated against such a generalization (CARR 1952; CALDWELL 1959; BRONGERSMA 1961; etc.) And now it is clear that this cannot be applied to the Sirahama specimens and in all probability either to other populations frequenting the coasts of southern Japan. Presence or absence of inframarginal pores, on the other hand, may be still useful as a clue for discriminating *Caretta* from *Lepidochelys*.

Head Shields. Considerable variations are found in the form and arrangement of the head shields, some examples of which are shown in Fig. 3. There is a large frontoparietal, which is usually partly divided into left and right halves by longitudinal incisures originating at the anterior and posterior borders (Figs. 3*a, b, c, d*); occasionally it may be completely divided by a continuous incisure (Fig. 3*e*). Frontal is hexagonal in shape and usuallly much smaller than frontoparietal; sometimes a minute shield may be inserted between the frontal and frontoparietal (Fig. 3*b*). Of the two pairs of prefrontals, the anterior pair are usually smaller than the posterior; in many cases the left and right prefrontals are partly or wholly separated from each other by the insertion of small additional shields (Figs. 3*a, b, c, e, f*). Usually four to six parietals are found; they are in most specimens much shorter than the frontoparietal in contrast with the case of *Lepidochelys olivacea*, in which parietals are fewer and larger.

Mandibular Scales. The shape and number of mandibular scales show a wide range of variation. Some specimens have three large scales in a horizontal row (Fig. 4*b*), often with the central scale of the series much smaller than others (Figs. 4*d, e, f*.) The central scale may be reduced so much that the anterior and posterior scales come into contact; in some specimens it is reduced to a small, triangular

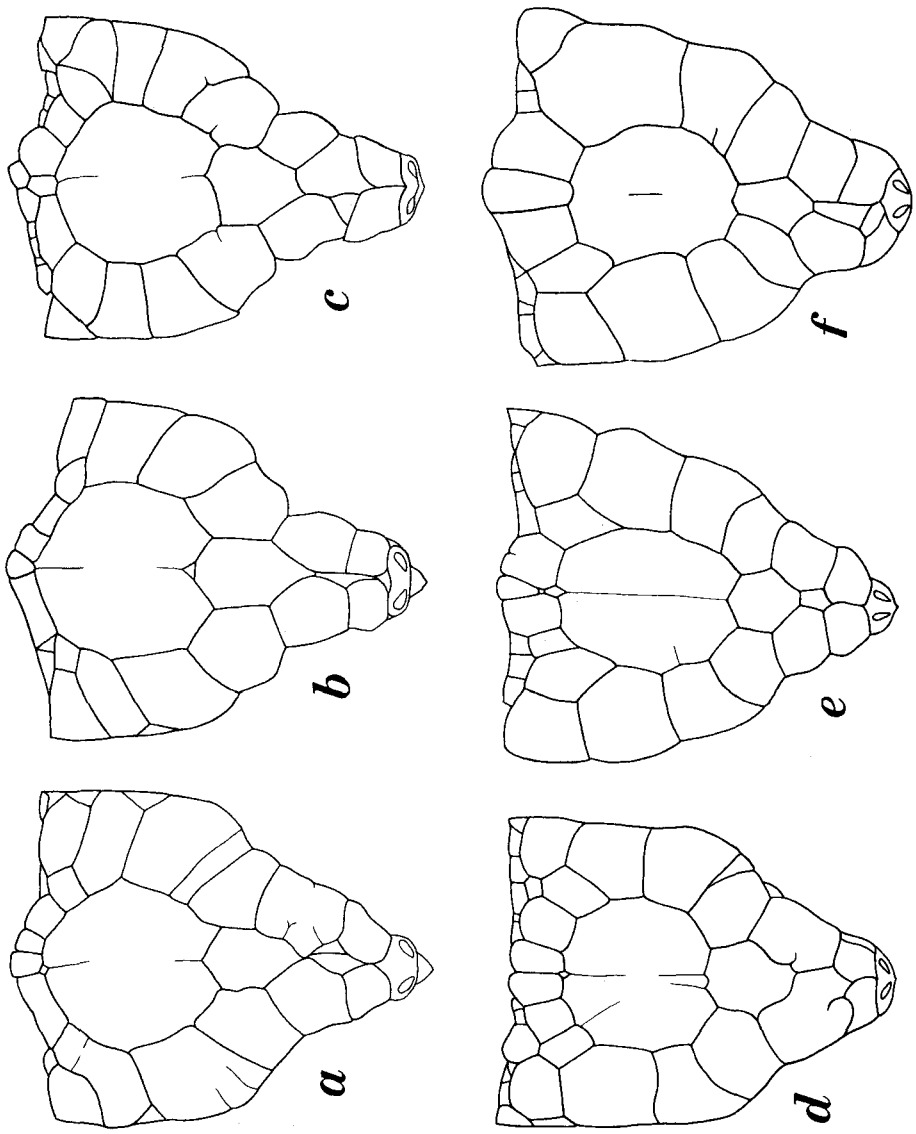

Fig. 3. Patterns of head shields in *Caretta caretta* (LINNÉ) from Sirahama.
a.-Specimen no. 6628; *b*.-Specimen no. 6632; *c*.-Specimen no. 6658; *d*.-Specimen no. OB4; *e*.-Specimen no. OB6; *f*.-Specimen no. OB9.

scale inserted between the lower parts of the other scales (Fig. 4*a*), and it may disappear completely as in the case shown in Fig. 4*c*. Such a pattern and variation in the arrangement of mandibular scales are quite similar to those found in the specimens from the Atlantic waters (cf. BRONGERSMA 1961).

Besides Sirahama and its vicinity, several places in southern Japan are known as the breeding grounds of the loggerhead turtles; these places are plotted on the map in Fig. 5. The turtles landing on these grounds or caught in the nearby waters were identified on actual specimens or their photographs, or on the description made in informations; and all of the identified individuals have proved belonging to *Caretta caretta*.

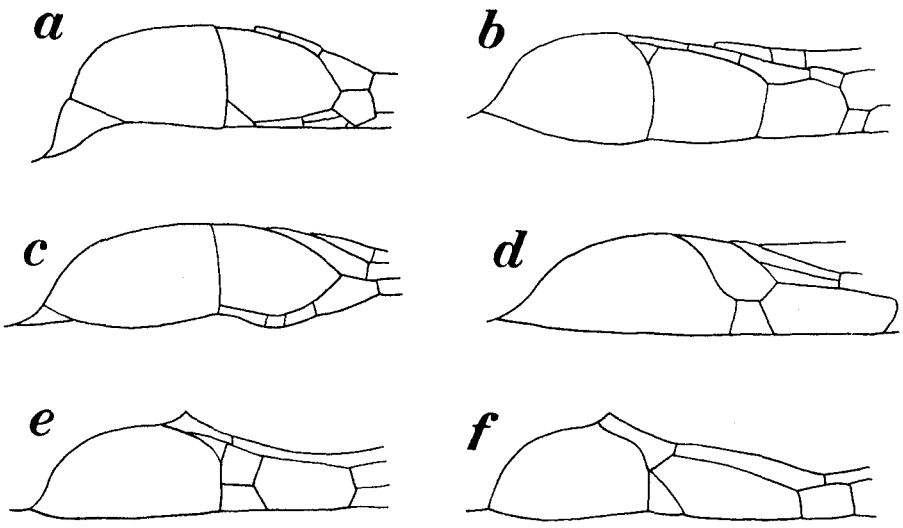

Fig. 4. Left mandibular scales in *Caretta caretta* (LINNÉ) from Sirahama.
a.-Specimen no. 6628; *b*.-Specimen no. 6632; *c*.-Specimen no. 6658; *d*.-Specimen no. OB4; *e*.-Specimen no. OB6; *f*.-Specimen no. OB9.

In certain places, this sea turtle is fairly abundant. For instance, the number of turtles landed on Gamôda coast, Tokushima Prefecture (no. 18 in Fig. 5), in the breeding season from spring to summer, is reported as 140 in 1957, 392 in 1958, and 750 in 1959[4]; populations breeding in the localities in southern Kyushu such as Miyazaki (no. 25 in Fig. 5), Daihô of Gotô Islands (no. 37) and Fukiage-hama, Kagoshima Prefecture (no. 30) are considered large enough to support the local commercial demand for turtle eggs as food[5]. However, it cannot be denied that the turtle populations as a whole are decreasing year after year in the Japanese waters. This is because of the destruction of their breeding grounds by terrible, thoughtless modification of beach on the one hand and of the uncontrolled collecting or killing of eggs and adults done quite freely in many of the breeding places on the other.

4) From a newspaper article in the *Asahi Shimbun* (ed. 5), Sept. 20, 1959.
5) From the article in the *Dobutsugaku Zasshi*, vol. 3, p. 517 (1891), YAMAGUCHI's (1966) paper and an information from Mr. S. KIMURA of the Fisheries Institute, Kyushu University (Oct. 12, 1966).

Distribution of the Loggerhead Turtles in the Western Pacific

From time to time loggerhead turtles are stranded on the coasts of northern Honshu. For instance, the following records are confirmed along the beach of Yamagata Prefecture; Mr. CHIYOTA SUGIHARA of Sakata City, who kindly checked every specimen, live or preserved, found that all recorded individuals were *Caretta caretta*, and sent me the details of his examinations.

Date	*Locality*	*Carapace length*
1909	Miyanoura, Sakata	ca. 80 cm
Before 1911	Kamo, Tsuruoka	ca. 100
Before 1938	Atsumi	91
After 1940	Yunohama, Tsuruoka	ca. 90
January, 1945	Jurizuka, Sakata	101
Mar. 10, 1961	Mejika, Yusa	85
June (?), 1961	Hôki, Tobishima Isl.	97
January, 1963	Jurizuka, Sakata	12
Jan. 14, 1964	Deshimizu, Yusa	95
February, 1964	Jurizuka, Sakata	10
Jul. 3, 1964	Nezugaseki	ca. 90
?	Jurizuka, Sakata	89

While he was searching for the specimens of sea turtles in that district, Mr. SUGIHARA found besides *Caretta caretta* three specimens of the hawksbill *Eretmochelys imbricata* (LINNÉ), two specimens of the green turtle *Chelonia mydas* (LINNÉ) and three specimens of the leatherback turtle *Dermochelys coriacea* (LINNÉ); it is apparent that the red-brown loggerhead is the commonest of the sea turtles caught along the coast of Yamagata Prefecture.

Caretta caretta may be observed similarly in other districts of northern Honshu, too. This sea turtle was once caught in Peter the Great Bay of the Maritime Province of the U.S.S.R. (TERENTJEV & CHERNOV 1949). The loggerheads caught occasionally on the coasts of Hokkaido (SH. NOZAWA in OKADA 1930; T. UENO, personal communication Nov. 16, 1966) most probably belong to the same species.

On the other hand, the olive loggerhead *Lepidochelys olivacea* seems very rare in the Japanese waters. So far, only two specimens are confirmed, one from northwest Kyushu and the other from the coast near Niigata (NISHIMURA & HARA 1967); of course, no definite record of breeding on the Japanese coasts. It seems that this turtle cannot breed in the waters surrounding Japan and a few individuals ever caught are nothing but strays from its natural habitat.

Loggerhead turtles are recorded also from Kwangtung, Fukien, Chekiang and Kiangsu on the Chinese continental coasts (FANG 1934, as *Caretta caretta*; POPE 1935, as *C. caretta olivacea*; SOWERBY 1936, as *C. olivacea*; HU et al. 1962, as *C. caretta*; etc.). According to POPE (op. cit.), they are seemingly rather rare in the Chinese waters; and the same may be true as to the neighboring waters of Hong Kong (HERKLOTS

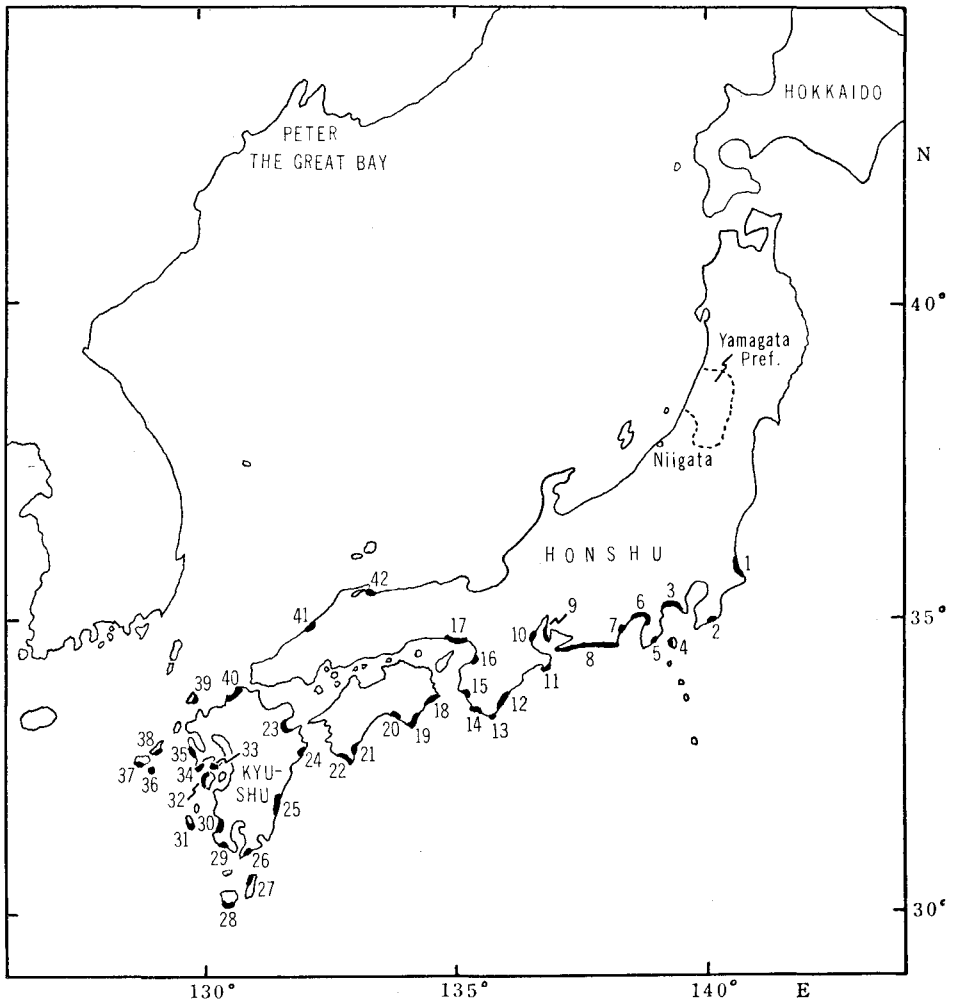

Fig. 5. Breeding places of *Caretta caretta* (LINNÉ) in Japan.
1.-Kashima Nada; 2.-Kamogawa to Amatsu (cf. IKEDA 1893; KURATA 1958); 3.-Odawara to Kamakura (cf. YOSHINAGA 1891; IKEDA 1893); 4.-Izu Oshima (cf. KURATA 1958); 5.-Izu Sirahama; 6.-Tagonoura; 7.-Miho; 8.-Irako to Omaezaki; 9.-Utsumi to Shin-Maiko (now abandoned); 10.-Shirako (now abandoned ?); 11.-Katada; 12.-Kumano Nada; 13.-Kushimoto; 14.-Susami, Sirahama and Minabe; 15.-Gobô; 16.-Takaishi; 17.-Maikohama to Suma; 18.-Hiwasa to Gamôda; 19.-Muroto to Sakihama; 20.-Aki; 21.-Ookihama; 22.-Oohama, Tatsukushi Sakurahama, Oogetus Matsusaki, Nishidomari Shurahama (cf. WADA & KOJIMA 1960); 23.-Bay of Beppu; 24.-Takenoura Gôchi; 25.-Oryuzako, Miyazaki and Akae; 26.-Satamisaki Oodomari; 27.-Tanegashima Hanasatosaki; 28.-Yakushima Kurio (cf. FUJIWARA 1966); 29.-Chiran coast; 30.-Fukiagehama; 31.-Koshikijima Teuchi; 32.-West coast of Amakusajima; 33.-Katsusa; 34.-Wakimisaki; 35.-Ooseto Yukinoura; 36.-Gotô Akashima; 37.-Daihô; 38.-Narao Takaitabi; 39.-Iki Tsutsugi (the data for Nagasaki Prefecture after YAMAGUCHI 1966); 40.-Shiganoshima, Tsuyazaki and Kôminato; 41.-Gôtsu Hashi; 42.-Yumigahama (cf. KAMITA 1962).

1931). FANG's (op. cit.) statement that it is very common off the Paracel Islands in the South China Sea needs confirmation, because there is a possibility that this author deals here with *Lepidochelys olivacea*. TAKASHIMA (1958) mentioned occurrences of '*C. caretta*' in Korea, the Loochoo (Ryukyu) and Formosa, but it is left uncertain whether those turtles were all *C. caretta* or some olive loggerheads were included. Nothing is mentioned as to *C. caretta* in SHANNON's (1956) report on the reptiles of Korea. CHEN's (1956) description of '*C. olivacea*' from Formosan waters seems to refer really to the red-brown loggerhead; but only Suao and Lanshui are listed as localities. WANG & WANG (1956) and WANG (1962) list '*C. caretta olivacea*' in the reptilian fauna of Formosa and Botel-Tobago (Kôtôsho), but it is quite uncertain whether or not it represents the true red-brown loggerhead. OKADA, N. (1891, as *Chelonia caouana*) and OKADA, Y. (1930, as *Caretta olivacea*) record occurrences of the loggerhead in the Bonin Islands; though it is unknown whether it belongs to the real *C. caretta* or not, the latter author mentions that '*C. olivacea*' is rare in Bonin waters, while the green turtle is very abundant there.

TAYLOR (1921, as *Caretta olivacea*) records occurrences of the loggerhead in Philippine waters; the single specimen he dealt with seems to be really an olive loggerhead according to his description and photographs, though it shows some morphological anomalies. In his monographic work on the turtles of Indo-China, BOURRET (1941) mentioned occurrences of *Eretmochelys imbricata*, *Chelonia mydas* and *Caretta olivacea* (=*Lepidochelys olivacea*), but *Caretta caretta* was not included in the cheloniid turtle fauna of that area; it is mentioned plainly that *C. caretta* (=*C. gigas* according to his nomenclature) had not yet been found along the coast of the Peninsula of Indo-China. The red-brown loggerhead seems uncommon on the South China Sea coasts of Malaya and Sarawak, too, as HENDRICKSON (1958, 1966) and HENDRICKSON & ALFRED (1961) do not mention any occurrence of this species in their reports on the breeding populations of sea turtles, especially in respect to the green turtle, on those coasts. DE ROOIJ (1915) listed up the following places as the localities of '*C. caretta*': Java (Batavia), Solor Island, Borneo, Celebes (Menado), Ambon, Aru Islands, New Guinea, N. & W. Australia, Philippines, and Malay Peninsula in addition to some exo-Pacific localities. Her citations, however, cannot be taken wholly valid, since her '*C. caretta*' seems to comprize *Lepidochelys olivacea* as well. According to GIBSON-HILL (1950), the sea turtle fauna of the Cocos-Keeling Islands, south of Sumatra, is represented by *Chelonia mydas* and *Eretmochelys imbricata* and that of Christmas Island, south of Java, consists of only *Ch. mydas*; the occurrence of *Caretta caretta* or *Lepidochelys olivacea* around these offshore islands is quite unknown.

On the data cited above, though they are still insufficient and rather fragmentary, it is considered that the red-brown loggerhead is rather scarce in the tropical and subtropical areas of the western Pacific in contrast with southern Japan where it is quite common.

As to the olive loggerhead, on the other hand, there are evidences suggesting

its frequent occurrences in the tropical-subtropical areas. TIRANT (1885, as *Caouana olivacea*) and BOURRET (1941, as *Caretta olivacea*) report this sea turtle from Indo-China; according to these authors, its scutes are abundantly used in local tortoise-shell industries, though they are of a lower quality—evidently this suggests its abundant occurrences in that area. The species seems also common on the South China Sea coasts of Malay Peninsula and Borneo (HENDRICKSON 1958; HENDRICKSON & ALFRED 1961). BRONGERSMA (1961) cited many specimens, mostly hatchlings, from Java, Flores in Lesser Sunda, Menado in Celebes, Philippines, Moluccas, Cape York in northern Australia, etc. Of the two loggerhead specimens reported by POPE (1935) from the Fukien coast, China, one (Shanghai Museum no. 2579) seems to belong to *Lepidochelys olivacea*, judging from the number of costal scutes (left 6, right 7). GADOW (1899) examined hatchlings from New Britain to formulate his 'theory' on the variation of the carapace scutes in loggerheads; those specimens are now considered as *L. olivacea* (cf. DERANIYAGALA 1933). Also it is to be remembered that the type specimen of *L. olivacea* was collected from the Bay of Manila (ESCHSCHOLTZ 1829), and that the localities of *Chelonia dussumierii* DUMÉRIL & BIBRON, 1835, *Ch. polyaspis* BLEEKER, 1857 and *Ch. dubia* BLEEKER in GRAY, 1864, all now placed in the synonymy of *L. olivacea* (LOVERIDGE & WILLIAMS 1957), were the China Sea (=South China Sea?), Java and Borneo, respectively. Finally, according to TAYLOR (1921), *'Caretta olivacea'*, presumably representing *L. olivacea* as suggested above, is not rare and is taken frequently in Manila Bay.

Meanwhile, the red-brown loggerhead becomes again very common in further southerly waters in the Southern Hemisphere. For instance, it is one of the sea turtles met with most frequently, together with the green turtle and hawksbill, in the Great Barrier Reef region of Australia (especially in the Capricorn-Bunker, i.e. the southern part of the region?) (YONGE 1930, as *Thalassochelys caretta*; MOORHOUSE 1933, as *Caretta caretta*; ROUGHLEY 1937, as *Th. caretta*; GILLETT & MCNEILL 1959, as *C. caretta*; etc.) Judging from the descriptions and photographs, there is no doubt in concluding that the loggerhead common in the Great Barrier Reef region are the true *Caretta caretta*. Breeding is known from further southern localities along the eastern coast of Australia: DERANIYAGALA (1939) examined a hatchling of the red-brown loggerhead from Bunderberg in southern Queensland (25°S). The occurrences of the same species off Western Australian coast are noted by GLAUERT (1928) and CAMPBELL (1947); it is possible that there are its breeding places on the same coast, as BABCOCK (1930) and BRONGERSMA (1961) report hatchlings from Shark Bay. For the records in South Australia, the work of WAITE (1929) is to be referred to. Further, according to SCOTT & MOLLISON (1956, as *C. caretta gigas*), the red-brown loggerheads are caught not infrequently in Tasmanian waters, too. On the other hand, no information of frequent occurrences of the olive loggerhead in Australia is known to the present author, except for its northernmost districts.

From the distributional features of the red-brown loggerhead mentioned so far,

it may be concluded that this turtle has two centers of abundant occurrences in the western Pacific, one in southern Japan and the other in Australian waters, but it is rather scarce in the tropical-subtropical region between those two areas. Thus, this sea turtle is to be called rather a warm-temperate species, but not a tropical-subtropical one as was previously believed generally. The few specimens captured in the tropical-subtropical waters may be stray individuals from the warm-temperate habitat. A similar pattern of distribution appears to be observed in the Atlantic populations of this species, too (cf. BABCOCK 1938; DERANIYAGALA 1943; CARR 1952; CALDWELL, CARR & HELLIER 1956; CALDWELL, CARR et al. 1959; etc.) In expressing such a pattern of geographical distribution, the term 'antitropical' suggested by HUBBS (1952) may be borrowed. As regards the tropical part of the Indian Ocean, DERANIYAGALA (1933, as *C. gigas*) states that the species is not uncommon in the Gulf of Mannar, Ceylon; strange enough, however, no definite information is made about its breeding in the Ceylonese waters, though both eggs and young of its relative *olivacea* are very common there. Are the bulk of the red-brown loggerheads captured in Ceylon the stray individuals derived from the southern temperate zone in the same way as this author (1960a, 1960b, 1961, 1965) suggested for some pelagic animals found in the Ceylon area?

The olive loggerhead, on the other hand, may be said a typical tropical-subtropical species like the remaining chelonine turtles. It is found commonly in all the equatorial waters in the eastern Pacific, the Indian, and the eastern and western Atlantic (DERANIYAGALA 1939, 1943; CARR 1952, 1957; LOVERIDGE & WILLIAMS 1957; VILLIERS 1958; BRONGERSMA 1961; PRITCHARD 1964; etc.) in addition to the western Pacific. The previous concept that the distribution of *Caretta caretta* covers the entire tropical and subtropical seas and often extends to the temperate waters is then considered to be originated erroneously by the confusion of the two species mentioned so far belonging to the same tribe, Carettini.

Summary

1. Detailed studies on the external morphology such as carapace dimensions and scute and scale arrangements were made on the loggerhead population breeding on the coast of Sirahama, southern Japan. The results indicate that the population consists of a single species: *Caretta caretta* (LINNÉ). Examination of the accessible specimens from other breeding places in southern Japan also revealed that they all belonged to the same species.

2. It seems very likely that *Lepidochelys olivacea* (ESCHSCHOLTZ), another carettine species much confused with *C. caretta* in Japan so far, does not breed in the Japanese waters. Only two records have hitherto been confirmed as to the occurrence of *L. olivacea* in Japan.

3. The breeding places of *C. caretta* in the Japanese waters are shown on a map. The population of this sea turtle in Japan is estimated to be of a fairly large size.

4. Records of occurrences of *C. caretta* and *L. olivacea* in the western Pacific are reviewed. It is concluded that the former is abundant in the warm-temperate regions in both hemispheres but apparently very scarce in the tropical-subtropical region between, while the latter is common in the tropical-subtropical waters and fades toward the temperate regions. The distribution pattern of *C. caretta* may be considered as an example of the 'antitropical' distribution.

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Note Added in Proof. After I submitted the manuscript for printing, I received from Dr. CHARLES MCCANN of the New Zealand Oceanographic Institute two very interesting papers on marine reptiles in the New Zealand waters ("Key to the marine turtles and snakes occurring in New Zealand." Tuatara, vol. 14, pp. 73–81, 1966; "The marine turtles and snakes occurring in New Zealand." Rec. Dominion Mus., vol. 5, pp. 201–215, 1966). From the descriptions, photographs and illustrations given in these papers, it is clear that both the red-brown and the olive loggerhead occur in the New Zealand waters, though they are lumped together under the name '*Caretta caretta*'. The occurrences of young specimens on Ninety-mile Beach, one of which is shown on Plate III of the paper in *Records of the Dominion Museum* and is almost certainly a young of the true *C. caretta*, suggest that there are its breeding places in nearby areas. It is much expected that further studies will be made to reveal the relative abundance of each of the species and whether or not these turtles, especially *C. caretta*, are really nesting in the New Zealand waters.